THE AMERICAN OIL CHEMISTS' SOCIETY

JOURNAL OF OIL & FAT INDUSTRIES

Vol. II APRIL, 1925 No. 2

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Published by The American Oil Chemists' Society, Easton, Pa.

Application for entry as second class matter made at the postoffice at Easton, Pa.

Contributions for the Journal should be sent to the Editor, Herbert S. Bailey, P.O. Box No. 309, San Dimas, Cal. Subscription and Membership Dues should be paid to the Secretary-Treasurer, Thos. B. Caldwell, Law & Co., Wilmington, N. C.

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Journal of Oil and Fat Industries

Devoted to Oils, Fats and Allied Industries

VOL. II APRIL, 1925 No. 2

EDITORIALS

THE 1925 CONVENTION

Our convention this year will be held at New Orleans in the Roosevelt Hotel, May 11th and 12th.

That it will be the biggest and most interesting gathering of Oil Chemists to date is a foregone conclusion. The American Oil Chemists' Society has more members today than ever before and the entire industry is in a far more prosperous condition than for several years past.

To those who have attended past conventions it is out of order to say that they are the one big opportunity of the year to get inspiration and information for one's work. Those who have never gathered with the rest of the clan, cannot be properly impressed by mere words with the importance of attending this meeting. It is a noticeable fact that when once an oil chemist goes to one of these conventions he generally gets the habit.

It isn't only the papers and committee reports, important as these things are, but the swapping of ideas and the getting personally acquainted with other workers in one's own field that makes such gatherings most worth while. Don't miss this meeting, if you can help it. If you have a job, you will learn something that will help you hold it, and if you haven't, come anyway and like-as-not you will hear of a good opening. Such things have happened before.

H. S. B.

REPORT OF THE EDITOR OF THE JOURNAL

By Herbert S. Bailey

The Journal of Oil and Fat Industries emerged from the chrysalis stage with the July, 1924, issue. At that time it metamorphosed from the Chemists' Section of the *Cotton Oil Press* and took unto itself a garb more becoming its dignity as the official organ of The American Oil Chemists' Society. Perhaps our simile is a bit uncomplimentary to the Cotton Oil Press, without whose help we could never have attained our winged state, but we do not mean it to be. The future life and perfection of form of the butterfly is wholly dependent upon the treatment received during its semi-dormant cycle. So whatever of merit attaches to the present Journal, is largely due to the nurture and kindly handling it received while hidden within the covers of the *Press*. The Editor realizes keenly his indebtedness to Mr. Geldert, the Manager of the *Press*, and gladly embraces this opportunity of expressing his appreciation for the many favors shown to him personally and through him to the Society as an organization.

Your Editor is not in a position to prepare at this time a proper report of the past year's activites. He should have a full tabulation of the income derived from advertising, a summary of the distribution of the Journal and statement of Editorial policy with its conventional frills. Because he has not, he submits a rather superficial survey of the three issues so far published and promises that when the last number of Volume II goes to press it will contain a more satisfactory report of the first eighteen months' life of your Journal.

Volume I was by direction of the Governing Committee issued in two numbers so as to start with a new pagination and volume with the calendar instead of the fiscal year. This report appears in the second number of the second volume and therefore covers only three numbers.

The details of the choice of a suitable form for the new Journal and the choice of printer, Managing Editor and Associates would cover more pages than you individually would care to read or collectively as a Society would care to pay for. Suffice it, therefore, to say that after much designing and revising, the present cover was evolved; and both Mr. Mack, the publisher, and your Editor are rather proud of it. Mr. Fred H. Smith, our Managing Editor, who has had full charge of advertising accepted this responsibility because of his interest in the Society and a journal devoted exclusively to the fat and oil industries. He has served practically without remuneration having used a large portion of his percentage of the advertising income in efforts to increase the publication's circulation. The Society owes him a much greater debt of gratitude than it realizes, for without his experience and everlasting persistence we would have had to draw heavily on our treasury for support of our periodical.

To the majority of your Associate Editors you are also indebted for no small amount of assistance which they have gratuitously given to the Editor and the JOURNAL. Miss MacDonald who was made the Editor's Assistant with the beginning of Volume II has taken care of all matters pertaining to subscriptions and the mailing lists. Perhaps we may be pardoned for inserting here this one personal expression of appreciation. Without her loyal and efficient assistance the job of keeping things moving smoothly when our habitation was shifted from the East to the West just simply could not have been accomplished.

The two numbers of Volume I contained 80 pages of original contribution, committee reports and editorials and 26 pages of advertising. The first number of Volume II, 31 pages of contributions, 3 of abstracts and 15 of advertisements. There have been altogether 26 authors of papers represented in our pages and 27 articles or reports published. To those who have helped make the JOURNAL what it has been, by submitting contributions, the Society owes much. The names which have appeared on the cover, of each issue are mostly familiar ones—names of those of our loyal members who believe in the Society enough to work for its advancement and do what they can to further its prestige around the world. In a year or two when we are fully established in the ranks of the scientific periodicals the problem will be how to find space for all the papers submitted, just now it is the Editor's nightmare, to locate enough of the right sort of stuff to fill each issue, and we will not publish unsuitable papers even if we have to go to press with blank pages.

Even a casual glance at the mailing list indicates that a most gratifying distribution of the JOURNAL is being attained. Among the nearly 325 subscribers are 13 in England, 5 in Canada and 1 or 2 in Australia, Denmark, Holland, Brazil, Mexico, India, South Africa, Norway, Haiti and France. We have already, in less than a year, thus circled the globe and are just getting started.

As to the cost of this venture to the Society, that will appear in the Treasurer's report in so far as it is possible for him to match up the expenses incurred in the fiscal year with the JOURNAL income which is largely on the calendar year basis. That it is not paying its way as yet is quite evident, but it is costing us little if any more than the Chemists' Section in the *Cotton Oil Press*, and if we can only increase our subscription list to the point where we can raise our advertising rates and thus get more income from both sources we can make it a monetary asset.

As a finale to this most unconventional report your Editor wishes to say that he believes as the Managing Editor has suggested, that the entire matter of the JOURNAL should be in the hands of one man. This means some one who will solicit both papers and advertising, edit manuscripts and collect advertising bills, read all proofs and solicit new subscriptions

and make collections and pay bills. If we can only find someone who does not know what a job all this would be, or who has an independent income and plenty of leisure, as well as the ambition and willingness to sacrifice for a noble cause, let us hire him forthwith.

P. O. Box 309, San Dimas, Calif.

PROPOSED CHANGES IN THE BY-LAWS

The following proposed changes in the Societies' By-Laws were considered by the Governing Committee in January and will probably come up for ratification at the New Orleans Convention.

Article II

Section (a):

Active members shall pay, in advance, each year on June first to the Treasurer of the Society, Six Dollars ($6.00) annual dues, of which Two Dollars and Fifty Cents ($2.50) shall be for a year's subscription to the Journal of Oil & Fat Industries.

Section (b):

Active-referee members shall pay, in advance, each year on June first to the Treasurer of the Society, Six Dollars ($6.00) annual dues, of which Two Dollars and Fifty Cents ($2.50) shall be for a year's subscription to the Journal of Oil & Fat Industries. Active-referee members shall pay in addition Two Dollars ($2.00) for the annual certificate of the Examining Board. Firms or Corporations shall pay Five Dollars ($5.00) for their annual certificate, with Two Dollars ($2.00) additional for each additional certificate.

Section (c):

Associate members shall pay, in advance, each year on June first to the Treasurer of the Society, Ten Dollars ($10.00) annual dues, of which Two Dollars and Fifty Cents ($2.50) shall be for a year's subscription to the Journal of Oil & Fat Industries.

Section (d):

Any member in arrears for dues on July fifteenth shall cease to be a member until all arrears are paid, when he may be reinstated by a majority vote of the Governing Committee.

Section (e):

In case a member is elected after April first of any year, the dues of which Two Dollars and Fifty Cents ($2.50) shall be for a year's subscription to the Journal of Oil & Fat Industries then paid shall continue him in good standing until June first of the following year.

This article as adopted at the 1922 meeting reads:

Section (a):

Active or Active-Referee Members shall pay to the Treasurer of the Society, Six Dollars ($6.00) annual dues, payable in advance, June 1st of each year. Active-referee members shall pay $2.00 for the annual certificate of the Referee Examining Board.

Firms or Corporations shall pay $5.00 for their annual certificate, with $2.00 additional for each additional certificate.

Section (b):

Associate members shall pay to the Treasurer of the Society, Ten Dollars ($10.00) annual dues, payable in advance, June 1st of each year.

Section (c):

Any member in arrears for dues on July 15th shall cease to be a member until all arrears are paid, when he may be reinstated by a majority vote of the Governing Committee.

Section (d):

In the case of members elected after April 1st of any year the dues then paid shall continue him in good standing until June 1st of the year following.

ORIGINAL CONTRIBUTIONS

THE CHEMICAL COMPOSITION OF CALIFORNIA OLIVE OIL

By George S. Jamieson and Walter F. Baughman

Hazura and Grüssner[1] report that the unsaturated acids of olive oil consist of approximately 93% oleic acid and 7% linolic acid. Hehner and Mitchell[2] were unable to detect stearic acid in the saturated acid portion. Holde,[3] while endeavoring to resolve the saturated acids into their components, obtained a small quantity of an acid with a molecular weight of 368.7 and a melting point of 72–72.8°C. In regard to this Lewkowitsch[4] says, "it is left open to doubt whether this acid is lignoceric acid (m. p. 80.5, mol. weight 368)." It is his opinion that the saturated acids consist of palmitic acid and a minute proportion of arachidic acid.

The oil used in this investigation was expressed in a commercial plant from Mission olives (crop of 1923) grown in Butte County, California. It was washed with water and filtered at the plant. It had a greenish color and a fine flavor.

Chemical and Physical Characteristics.—The more important characteristics of olive oil are recorded in Table I. The percentages of saturated and unsaturated acids were determined by the lead salt-ether method and corrections were made for the small quantity of unsaturated acids

Table I

Olive Oil

Physical and Chemical Characteristics

Specific gravity $\frac{25°}{25°}$	0.9119
Refractive index 20°	1.4690
Acid value	1.5
Iodine number (Hanus)	85.1
Saponification value	190.6
Unsaponifiable matter (%) (iodine number 170.6)	1.0
Acetyl value	11.2
Saturated acids (determined) (%) (iodine number 7.5)	9.7
Unsaturated acids plus unsaponifiable matter (determined) (%)	85.6
Iodine number of unsaturated acids plus unsaponifiable matter	95.7
Iodine number of unsaturated acids	94.8
Saturated acids (corrected) (%)	8.9
Unsaturated acids (corrected) (%)	85.2

[1] *Monatsh.*, **9**, 944 (1888).

[2] *Analyst*, **21**, 328 (1896).

[3] *Ber.*, **38**, 1250 (1905).

[4] "Chemical Technology and Analysis of Oils, Fats and Waxes," Macmillan & Co., 6th ed., **2**, 362 (1922).

that contaminated the saturated acid fraction.[5] The percentage of unsaturated acids was also corrected for the unsaponifiable matter, all of which separates with the unsaturated acids fraction. The iodine number of the fraction containing the unsaturated acids and the unsaponifiable matter is 95.7 and the iodine number of the unsaponifiable matter is 170.6. The iodine number of the pure unsaturated acids, therefore, is 94.8.

Unsaturated Acids.—The iodine number of the unsaturated acids fraction (94.8) indicates that it consists of oleic acid (iodine number 90.1) and linolic acid (iodine number 181.4). Using the iodine numbers, the percentages have been calculated as follows:

		Original oil	Glycerides
	%	%	%
Oleic Acid	94.85	80.81	84.4
Linolic Acid	5.15	4.39	4.6
	100.00	85.20	89.0

Saturated Acids.—A quantity of the saturated acids prepared by the lead salt-ether method was esterified with methyl alcohol (*J. Am. Chem. Soc.*, **42,** 1200 (1920)). This mixture of methyl esters was fractionally distilled under diminished pressure. The data for this distillation are given in Table II. A preliminary distillation was made from a 1-liter Claissen flask; seven fractions (A, B, C, D, E, F, G) and a residue were obtained. The preliminary fractions were redistilled from a 250 cc.

TABLE II

FRACTIONAL DISTILLATION OF METHYL ESTERS OF SATURATED ACIDS

(126.3 g. subjected to distillation)

Distillation at 6 mm. pressure.

	Fraction	Temperature °C.	Weight G.
	A	172	22.95
	B	173	22.39
	C	173–174	22.60
	D	175–178	22.30
	E	179–184	22.72
	F	185–192	10.13
	G	192–203	2.60
	Residue		0.25
Fractions A and B redistilled	1	165–170	4.80
	2	171–172	24.20
Fractions C and D added	3	172–174	23.40
	4	175–178	24.00
Fraction E added	5	179–184	18.80
Fraction F added	6	185–194	21.60
Fraction G added	7	195–205	6.00
Residue added	8	205–215	3.10
	Residue		0.23

[5] *J. Am. Chem. Soc.*, **42,** 2398 (1920); *Cotton Oil Press*, **6,** 1, 41 (1922).

Ladenburg flask according to the manner indicated in the table; eight fractions and a residue were obtained.

The iodine numbers, which are measures of the contaminating unsaturated acids, and the saponification values of Fractions 1 to 8 are given in Columns 2 and 3 of Table III. Using these data, the mean molecular weights of the saturated acid esters in each fraction were calculated as recorded in Column 6 (*J. Am. Chem. Soc.*, **42,** 152, 1197 (1920)).

The results in Column 6 indicate what saturated acids may be present in the fractions. The mean molecular weight of the saturated acid esters in Fraction 1 is slightly less than that of methyl palmitate (270.3) and indicates that this fraction contains principally methyl palmitate and a little methyl myristate. The results for Fractions 2–7 lie between the molecular weights of methyl palmitate and methyl stearate (298.4), which indicates that the fractions contain these esters in various proportions. The probable constituents of Fraction 8 are methyl stearate and methyl arachidate (326.4).

The free mixed acids were recovered from some one of these fractions by saponifying with alcoholic potash and acidifying the soap solution with hydrochloric acid. The constituent acids were then isolated by fractional crystallization from alcohol. Their identity was established by the melting points and by whether or not these melting points were lowered when the substances were mixed with equal quantities of the respective acids which they were suspected of being and the purity of which had been established previously by elementary analysis.

In all cases the melting points of the isolated acids confirmed the deductions drawn from the mean molecular weights of the fractions.

Arachidic acid ($C_{20}H_{40}O_2$), which melted at 77°C., was isolated from Fraction 8. No acid with a higher molecular weight could be detected in this fraction. Stearic acid ($C_{18}H_{36}O_2$), which melted at 69°C., was isolated from Fractions 6 and 7. Palmitic acid ($C_{16}H_{32}O_2$), melting at 63°C., was crystallized from Fraction 1. By reducing the volume of the mother liquor from Fraction 1, several crops of pure palmitic acid crystals were obtained. Finally a very small crop of crystals with a melting point of 56–57°C. was obtained. The crop was too small to recrystallize. It is believed that this crop consisted of palmitic and myristic acids. The melting point of pure myristic acid is 54°C. and the formula is $C_{14}H_{28}O_2$.

This establishes the identity of the saturated acids in the various fractions. The quantities were calculated from the mean molecular weights of the saturated acid esters (Column 6, Table III) and the theoretical molecular weights of the two esters in each fraction. The results are given in Columns 7–14, Table III. The small residue contained only decomposition products.

TABLE III

OLIVE OIL

FRACTIONAL DISTILLATION OF METHYL ESTERS OF SATURATED ACIDS

Fraction	Iodine number	Saponification value	Mean molecular weight	Esters of unsaturated acids %	Mean molecular weight of esters of saturated acids	Myristic Acid %	Myristic Acid G.	Palmitic Acid %	Palmitic Acid G.	Stearic Acid %	Stearic Acid G.	Arachidic Acid %	Arachidic Acid G.
1	2.7	207.7	270.1	2.99	269.3	3.26	0.16	88.70	4.26				
2	3.2	206.2	272.1	3.54	271.3			88.21	21.35	3.27	0.79		
3	5.5	205.7	272.7	6.09	271.3			85.88	20.10	3.18	.74		
4	6.6	204.4	274.5	7.31	272.9			79.76	19.14	8.17	1.96		
5	12.2	196.3	285.8	13.51	283.9			42.32	7.96	39.90	7.50		
6	17.8	193.6	289.8	19.71	287.8			28.72	6.20	47.66	10.30		
7	18.1	188.4	297.8	20.04	297.6			2.16	0.13	74.04	4.44		
8	12.2	178.9	313.6	13.51	316.1					30.33	0.94	52.32	1.62
							0.16		79.14		26.67		1.62

In Table IV the percentage composition of the saturated acids is given in Column 2, the percentages of saturated acids in the original oil in Column 3, and the equivalent percentages of glycerides in Column 4.

TABLE IV

OLIVE OIL

SATURATED ACIDS

Acid	Acids in saturated acid fraction		Acids in original oil	Glycerides in original oil
	G	%	%	%
Myristic	0.16	0.15	0.01	trace
Palmitic	79.14	73.56	6.55	6.9
Stearic	26.67	24.79	2.21	2.3
Arachidic	1.62	1.50	0.13	0.1
	107.59	100.00	8.90	9.3

Summary

The chemical composition of olive oil from Mission olives has been determined, with the following results:

	Acid	%
	Oleic	84.4
	Linolic	4.6
	Myristic	trace
Glycerides of	Palmitic	6.9
	Stearic	2.3
	Arachidic	0.1
Unsaponifiable matter		1.0

Stearic acid constituted approximately 25% of the saturated acids. It is believed that the much discussed question regarding the presence or absence of stearic acid in olive oil has been definitely settled by this investigation.

MACADAMIA NUT AND ITS OIL

BY C. A. LATHROP

The Macadamia or Queensland Nut (Macadamia ternifolia F. v. M.) is a native of the coast district of Queensland and the north coast district of New South Wales, Australia, where it is also known as the "Bush Nut" and "Possum Nut." Seeds of this tree were introduced into Hawaii about 1883 and a considerable growth has since been developed, and it is one of the most promising of nuts for commercial cultivation within the tropics and sub-tropics.

The tree is very ornamental, has a dense foliage, attains a height of about 35 feet, and the nuts occur singly or in clusters up to as many as eight. The nuts have leathery husks which often open on the tree; the chocolate colored spherical shell is about 3 mm. thick and very hard

to crack. The kernel is white and about 19 mm. in diameter, nearly spherical or slightly flattened and often double and hemispherical.

The trees begin to bear from 3 to 8 years from planting, and the nuts fall to the ground when ripe, consequently not requiring harvesting by picking. The trees often produce nuts for more than half the year but may, however, vary greatly in respect to productivity, size of nuts, bearing age and character of foliage. The Macadamia is on the whole a very vigorous tree and not subject to much attack by insect pests.

PHYSICAL ANALYSIS

(Average of 300 husk free nuts)

	Per cent	Gm. per nut
Shells	70.9	6.00
Meat	29.1	2.47
	100.0	8.47
Size		20 to 30 mm.

ANALYSIS OF MEAT AND PRESS CAKE

	Meat %	Press cake %
Crude Protein (Nitrogen × 6.25)	8.6	35.6
Crude Fat (Ether Extract)	76.5	8.0
Crude Fiber	1.7	7.0
Ash (Mineral Matter)	1.9	7.7
Nitrogen Free Extract (Carbohydrates)	8.2	33.7
Moisture	3.1	8.0
Total	100.0	100.0
Calories per pound	3540	1627

ANALYSIS OF PRESSED OIL

Specific Gravity at 15.5°C.	0.9141
Refractive Index at 15.5°C.	1.4698
Saponification Number	193.7
Iodine Number	74.2
Unsaponfiable Matter	0.32%
Acid Value	0.22
Solidifying Point	−12.2°C.
Lovibond Color:	
Yellow	4.0
Red	0.6

The oil, which is over 76% of the edible portion of the Macadamia nut is quite unique, in that it does not deposit until about 0°C. is reached, does not solidify until —12°C., is almost colorless and its acid value is but 0.22. Such an oil would prove of great value for various edible purposes, particularly as a bland and delicious salad oil. The flavor and texture of the meat is more delicate than that of the Brazil nut which it more nearly resembles than any of the others in flavor.

When this valuable and productive tree becomes more generally known, and planted in quantities to be of commercial importance, it will offer a very valuable product in the way of oil, oil cake and a table nut that cannot be excelled in richness and delicacy of flavor.

It has an oil content of 76.5%, about 5% higher than the Pecan, containing the highest oil contents (71%) known in table nuts. The next highest of the commoner varieties are the Hickory and Brazil nuts with about 67%, the Filbert with about 65%, Walnut 64%, Almond 54% and Peanut 45%.

CURTIS AND TOMPKINS,
SAN FRANCISCO, CAL.

THE COMPOSITION OF MOWRAH-SEED OIL[1]

BY AUGUSTUS H. GILL AND CHAMPAK C. SHAH

Mowrah-seed oil or Mowrah butter is derived from the seeds of the Bassia latifolia, a tree widely distributed in India. It is an important food stuff in the northwest provinces of India: it is also used for candle and soap making, and medicinally as an ointment. The seeds contain about fifty per cent of oil. The oil is decidedly yellow, but not from carotin, and soon begins to bleach and finally becomes colorless in contact with the air.

The ground press cake of the seeds resembles powdered cocoa and is poisonous owing to its saponin content. It is used in India as a fertilizer and an emetic, in this country it is employed in insecticide powders on account of its poisonous properties.

No definite information regarding the composition of the oil is found in the literature. Menon,[2] found widely varying results: from 13–25 per cent of stearic acid and no arachidic acid: Lewkowitsch[3] found palmitic acid.

The oil used in this investigation was imported from Gujarat, a part of the Bombay Presidency, India, in the autumn of 1922 and was examined in 1923–1924. It was found to contain considerable free fatty acid which

TABLE I

MOWRAH-SEED OIL—CHEMICAL CHARACTERISTICS

Saponification value	206.5
Iodine number (Hanus)	57.9
Reichert-Meissl value	0.7
Polenske number	0.9
Acetyl value	3.3
Acid value	14.15
Unsaponifiable matter	0.8

[1] Contribution No. 87 from the Technical Analysis Laboratory of Mass. Inst. of Technology.

[2] *J. S. C. I.* **29,** 1429.

[3] *Oils, Fats and Waxes,* 5th ed., **II,** 518.

is usually the case. It was not of sufficiently good quality to be used for edible purposes.

The characteristics of the oil are shown in Table I.

The amounts of soluble or volatile fatty acids are negligible, as shown by the low Reichert-Meissl and Polenske numbers: the same is true of the hydroxy acids or mono- or diglycerides—as shown by the low acetyl value: a similar statement can be made regarding high unsaturated acids—indicated by the iodine value.

The various acids were determined in the oil by the Gusseron-Varrentrapp lead-salt-ether method as used by Baughman and Jamieson[4] in their work on Soya Bean and Sunflower-seed oil, which enables the separation of the saturated and unsaturated fatty acids. The nature of the latter was determined by their bromine addition derivatives. The nature of the saturated acids was determined by their methyl esters, their molecular weights and their melting points, also as detailed by the above-mentioned authors. The method has been now so thoroughly worked out by them that detailed figures seem a waste of space. From our investigations, the chemical composition of Mowrah-seed oil would seem to indicate the glycerides of the following acids:

	%
Clupanodonic	trace
Linolic	13.3
Oleic	40.2
Stearic	2.0
Palmitic	26.6
Myristic	16.1
Unsaponifiable matter	0.8

MASSACHUSETTS INSTITUTE OF TECHNOLOGY,
CAMBRIDGE, MASS.

FUTURE TRADING AS INSURANCE IN THE COTTON SEED OIL INDUSTRY

BY CARL L. ALSBERG

The manufacturer who faces violent fluctuations in the price of his raw materials may be ruined by such fluctuations, be he ever so efficient in manufacturing. The greatest conceivable manufacturing efficiency and skill may be unavailing if fluctuations in price of raw materials unforeseen by the manufacturer occur. To keep out of the bankruptcy courts he must be a shrewd buyer, often virtually a gambler in raw material as well as a legitimate manufacturer. If he manufactures to order for future delivery a sharp rise in raw material may ruin him. If he manufactures for sale on the open market, a drop in price of raw materials coming after

[4] *J. Am. Chem. Soc.*, **44**, 2947–2957 (1922).

he has made his purchases may keep his production costs above those of his competitors who have bought raw materials later so that he may have to take a loss. Even if he has bought wisely, he may have difficulty in disposing of his wares at a profit if there has been overproduction in his line or if the relative purchasing power of his customers has declined. Low purchasing power may result from lack of prosperity due to causes far remote from those that affect his own line of business, or it may be due to the fact that his goods, because of high production costs, are so high in price that his customers curtail consumption. Such high prices will usually depend, at least in part, upon high cost of raw materials, so that a good part of a manufacturer's selling difficulties will be tied up with fluctuation in price of raw materials. It is clear that fluctuation in price of raw materials is one of the very serious speculative risks a manufacturer has to face.

Now speculation and manufacturing require quite different types of mind, quite different orders of ability, quite different temperaments. One could almost believe that the traits of character which make a successful speculator preclude their possessor having at the same time the traits to make him a successful manufacturer. If this idea is sound, one would expect manufacturers to take advantage of any known method of insurance against fluctuation in price of raw material. Yet in many industries such insurance is either not employed at all or only inadequately. The cotton oil industry is such a one. In this regard it differs sharply from the cotton industry. This difference in the practice of the two industries is, I believe, responsible to an important degree for the different fate the two industries suffered in the post-war deflation period. The form of insurance to which I refer is future trading.

Before attempting to analyze the use of future trading by the two groups of industries, let us consider how future trading is used as a method of insurance against loss from fluctuation in the price of raw materials. Let us use as an illustration the milling industry in which future buying and selling is very general and the operations are relatively simple.

If a miller is asked to quote a price for flour to be delivered at some time in the future, he turns at once to the quotations on wheat for future delivery to learn the price of the future for the month closest to the one in which the flour is to be delivered. This is the basis upon which he calculates his price. If he receives the contract, he at once buys futures for wheat in an amount sufficient to furnish the raw material for the flour he has contracted to deliver. Thereafter fluctuations in the price of wheat worry him not at all. As fast as he buys wheat for the manufacture of the contract flour, he closes out a corresponding portion of his future trade. If in the meanwhile wheat has dropped in price, he secures the actual wheat for grinding for less than he expected; but he is not the gainer

thereby since he loses a corresponding amount on his future trade. If, on the contrary, wheat has in the meanwhile risen in price, he pays more for the actual wheat he requires than he expected, but he is not the loser thereby, since he gains a corresponding amount on his future trade. He renounces the hope of speculative gains but avoids speculative losses. He has insured himself against the hazard of fluctuation in the price of his raw material, and may reasonably count upon the profit which his manufacturing enterprise as such may warrant.[1]

If a miller is unable to sell his output in advance but must rely upon selling it on the open market as it is produced, he buys wheat from day to day to keep his mill in operation and sells each day a corresponding amount of future wheat. Then as fast as he sells flour, he buys in a corresponding amount of his future sales of wheat. If, between the time of the purchase of the wheat and the sale of the flour made from it, the price of wheat has dropped, the price of flour will ordinarily have dropped proportionately. However, the miller suffers no loss because what he loses in the sale of the flour he gains back in the closing of his future trade. Conversely, if the price of wheat has risen and with it the price of flour, he gains nothing thereby, for what he might have gained in the sale of the flour he loses in closing out his future trade. His operations have been insured. This practice is known in the trade as "hedging."

Economists who wanted to evaluate the role of future trading and speculation in the national economy have often endeavored to determine whether the fluctuations in price of commodities in which there is an extensive future market is less then the fluctuation in price of commodities without such a market.[2] It has been assumed at times that only if future trading narrows the range of price fluctuations, can future trading be justified. This view, however, presents but one phase of the question. The farmer, who is not so situated that he can hedge against his crop, may be benefited if future trading narrows the range of price fluctuation and injured if the range is increased. On the other hand, to the manufacturer using the farmer's crop and hedging, price fluctuations are in the

[1] It is illuminating to realize that of the flour mills in this country those have fared worst in the deflation period that are located in that section of the country where there is no future market for wheat and where it is not possible for the miller to hedge, because in that locality the spot price does not fluctuate in accordance with the future price at Chicago. I refer to the Pacific Coast. There the flour mills in the period of deflation suffered severely, while their competitors east of the Rocky Mountains suffered from overexpansion of milling capacity rather than from the violent fluctuations in the price of wheat, since the millers east of the Rockies were able to hedge. There were cases on the Pacific Coast in which mills had on hand large stocks of grain bought at the high war prices and had to sell the flour produced from this grain on the basis of the low wheat prices that followed deflation.

[2] Cf. H. H. Brace: "The Value of Organized Speculation," page 55. New York, Houghton Mifflin, 1913.

main a matter of indifference. He is insured against them. He is interested of course in not having the price of his raw materials at so high a level as to raise the price of the finished product to such a degree as to reduce consumption. Looked at from this angle, future trading done for hedging purposes is of service to the manufacturer whether or not price fluctuations are widened or narrowed thereby.

If we wish to evaluate future trading from this point of view, we should compare the profits and losses of two groups of manufacturers, of which one practices hedging, while the other does not. Two such groups of manufacturers would be cotton spinners as compared with cottonseed crushers, cotton oil refiners and soap manufacturers. Anyone at all familiar with these industries knows that there have been enormous losses among cotton crushers, cotton oil refiners and soap manufacturers; that some of them, indeed, have had to go to the wall during the post-war period. On the other hand, no such widespread complete disaster has hit cotton spinners as a class. To be sure, cotton spinners have had bad years since the war and have not always paid their customary dividends. It is also true that in some sections the outlook is discouraging. This, however, is not the result of fluctuations in the price of cotton but is rather due to other causes such as a shift of the center of the industry southward and westward in response to the economic development of the country. It is also true that the industry as a whole has suffered from the high level of prices and the consequent curtailment of consumption. The fact remains that the cotton spinning industry is not strewn with wreckage as is the cotton oil industry. This is particularly evident if one examines the balance sheets of the two groups of corporations and notes especially the shrinkages of inventories. These have been enormous in the cotton oil and soap industry; they have been relatively small in the textile industry. The situation is very well put by one large producer and user of cotton oil in the following language: "During recent years the cottonseed oil business has become increasingly speculative, hazardous and unprofitable. Market prices have been subject to violent fluctuations. This fact coupled with the high price levels which have prevailed creates a risk many times greater than that which prevailed during the earlier period. Under such conditions, price fluctuations completely overshadow any legitimate manufacturing profit which can normally be expected." The enormous shrinkage of inventories in the cotton oil industry was due in large measure to the sudden great drop in price of fats and oils. The corresponding drop in price of cotton did not injure spinners to the same degree, for most of them do not customarily carry large stocks of cotton whereas cotton oil producers and users commonly do so. There is even some evidence that cotton oil users carried larger stocks than normal, as the peak of prices approached. This is but the natural psychological

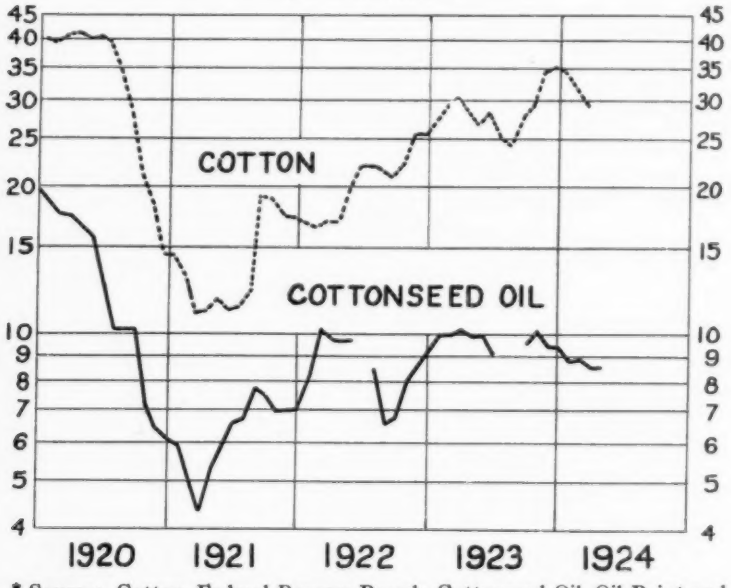
reaction to the upward trend of prices. Manufacturers fearing still higher price levels, and perhaps also hoping for speculative gains, not unnaturally pyramid and accumulate larger stocks than in normal times.

The contrast between the cotton and the cotton oil industries in regard to stocks carried depends in part upon the contrasting practices of the two industries with reference to future trading. In the case of a commodity like cotton or wheat, in which there is a very large speculative market and a large volume of future trading, there has developed a group of traders who specialize in risk taking just as much as an insurance company, but they also, as a necessary part of taking the risk, carry the commodity, that is to say, buy it at the time of surplus production and store it against future need in the hope of making a profit thereby. In the absence of a large future market, the bulk of a commodity must be carried by producers, manufacturers and consumers. Thus we see that the bulk of the cotton oil produced is actually held and owned by manufacturers, whether they be crushers or refiners or ultimate users like soap and oleomargarine manufacturers. The cotton spinner, because a large proportion of the cotton crop is soon in second and third hands, knows that it is unnecessary for him to pile up in his warehouses large quantities of his raw material. He can get it from month to month from these second and third hands, the specialists in the taking of risks in connection with the cotton trade. The soap manufacturer has no such large reservoir to call upon. He cannot so readily buy from month to month. He carries large stocks and takes the risk when he is not, and should not be, a specialist in risk taking. The consequence is that in times of rapid drop in prices the shrinkage in value of his inventories may be enormous. Since the cotton spinner need not carry large stocks of raw material, his losses at such times need not be heavy.

The flour miller is in much the same position as the cotton spinner. He is not usually at the same time an elevator man and a grain merchant. He lets the elevator man and the grain merchant, who are specialists in their respective fields, take the risks of handling and holding wheat. He keeps in his mill only a limited supply, knowing that because of the high specialization in the wheat trade he can get what he needs as he needs it. Millers who for any reason are compelled to carry considerable stocks of grain without hedging have greater hazards to face than millers who hedge. It may lead to severe losses, as was indicated above in the case of the millers of the Pacific Coast. And this is exactly the case of many of the cotton oil refiners soap concerns and others handling fats and oils. They have either not hedged at all or have hedged to a very limited extent, or have used the future market for speculation rather than for hedging. They have had to be gamblers in raw materials before they could manufacture. They have been amateurs as gamblers, however efficient they may have been as manufacturers, and they have been shorn like any other lamb.

Having made it clear how future trading may serve as insurance, let us apply the thoughts developed to the cotton oil and the cotton industry. That we may visualize the difference in the fate of the two industries, let us consider the course of prices in the post-war period. Prices for both cotton oil and cotton rose greatly during the war. They reached their peak in 1919–1920. The appended chart depicts the course of prices from 1920 onward. It shows that beginning in 1920 there was a sharp drop in prices which continued into 1921. Thereupon recovery began. Ever

Monthly prices of cotton (middling upland at New Orleans) and crude cottonseed oil (New York) 1920–24.*
(*Cents per pound.*)



* Source: Cotton, Federal Reserve Board; Cottonseed Oil, Oil Paint and Drug Reporter, first of each month.

since the trend of cotton prices has continued upward with fluctuations, until a level has been reached not very far below that of the war period. On the other hand, the recovery of cotton oil prices continued only into the early months of 1922. Since then the trend has been slightly downward. The price level attained is far below that of the war period.

If we search for reasons for the behavior of the two commodities, we are driven to the conclusion that cotton prices behaved as they did because there has been no permanent overproduction of cotton as a result of the war and that the probabilities point to no overproduction in the near future. Quite the reverse of overproduction has prevailed—practically a shortage of raw cotton and limited output of finished product.

If this had not been the case, if the war had expanded cotton production materially beyond the world's demands, prices could not have rebounded so rapidly nor could they now be so high. In the case of cotton oil, on the other hand, we are driven to the opposite conclusion, namely, that there is either an overproduction of cotton oil in itself or, what amounts to the same thing, that there has been expansion in the production of commodities which can be substituted for it and which are produced under conditions favorable enough to maintain their production to an extent sufficient to affect greatly, cotton oil prices. It is difficult, if not impossible, to account for the course of cotton oil prices in the post-war period in any other manner.

The competition which it would seem cotton oil has to face is not solely the result of war-time stimulation of production of competing commodities. War-time stimulation, especially of tropical fat and oil production, is responsible in part, but only in part, for the competition. The revolution which has been going on for more than a decade in fat and oil technology is also responsible in large measure. Modern processes of refining oils and hardening them by hydrogenation account to no small degree for the situation. These improvements in manufacturing methods are permanent factors that will continue to exert their influence long after the effects of war have disappeared. Hydrogenation has made the non-drying oils more or less interchangeable for certain purposes. Some inedible fats and oils can be made edible; oils can be given the consistency of butter, of lard or of tallow. The chemist has only begun his work in this field and we may with confidence look forward to very extensive interchangeability in the not too distant future. The effect in some respects is, even today, equivalent to increasing the supply of the more highly prized oils like cotton oil. Cotton oil must feel such competition especially keenly, for it is a by-product. The quantities produced will not vary greatly with the demand, since they are determined by the size of the cotton crop. Seed is produced so long as cotton is grown. The supply of cotton seed, therefore, can be restricted only by destroying it or using it as fertilizer or feed. Since, as we have seen, there is no propsect of a restriction in the production of cotton, there can be no deliberate reduction in the production of cotton seed.

Before the war probably no one had any definite ideas concerning the capacity of the world, under pressure, to expand the production of different commodities. Without such prevision it was impossible to foresee the course of prices after the war. The events that occurred in the business world following the war show clearly how difficult it is for even the most experienced to foresee trends of prices when unusual occurrences take place. They emphasize the importance to manufacturers of some form of insurance against price fluctuations.

In the face of the hazards growing out of price fluctuations manufac-

turers who use cotton and cotton seed or cotton oil, respectively, have been in very different positions. The former have not had to be gamblers in raw materials; the latter have been compelled to be. The reason for the difference between the two groups is that it is easy and safe for the cotton spinner to insure himself against the risk of violent fluctuations in the price of his raw material. He does so by buying or selling cotton for future delivery, that is. by hedging. He is able to hedge effectively because a world market for cotton exists, with world quotations and an active trade in cotton for future delivery. The user of fats and oils, for example, the soap boiler or the producer of cotton oil, the crusher, does not find it equally safe to protect himself by hedging because the future market for fats and oils is relatively undeveloped. There is, to be sure, a future market on the Chicago Board of Trade for lard; and there is also a future market on the New York Produce Exchange for cotton oil where in 1921, 4,162,600 and in 1920, 4,331,200 barrels were sold for future delivery. This is little more than the annual production. During the last two years the volume of trading has been a trifle less than twice the production of cotton oil, a relatively small volume of future trading as compared with the future sales of cotton which amount to many times the crop. The market is narrow and under present conditions any extensive operations have a very marked effect upon it. To the extent therefore that greater volume of future sales causes the future price to represent more exactly the spot price plus carrying charges, the protection the spinner might secure by hedging is more perfect than that open to the cotton seed crusher, the cotton oil refiner, or the soap manufacturer. Moreover, there is no certainty that the prices of a variety of oils, for example, soya bean, cotton, peanut or coconut, will fluctuate to the same degree together. There is no future market for them.

A wide future market for fats and oils in general is today more feasible than ever because, as has been pointed out, improvements in methods of refining and the introduction of hydrogenation have made certain fats and oils mutually more interchangeable than formerly. The result is that we are tending toward a condition in which the different fats and oils ought naturally to fluctuate together and to bear to each other fairly constant price ratios. Even fats devoted to special uses, such as lard, for example, are coming to behave in this way, owing to the fact that hydrogenation has made so many different fats and oils interchangeable. However, while we are tending toward a condition of free interchangeability, it must be admitted that we have not yet reached it. Something still remains to be done in the modification of fats and oils by chemical treatment, but more remains to be done in the education of users. Moreover, in the United States the tariff structure creates differentials not based on the intrinsic properties of the materials.

If all this be true, the time has come when it ought to be possible to create a more perfect future market in the fat and oil industry than now exists. Today certain oils are apparently more perfectly interchangeable than different varieties and grades of wheat, and they are more easily graded. Yet, despite the very real difficulties in establishing grades and standards for wheat, a broad future market for wheat exists. Fats and oils, because they are more easily graded and standardized, are much more suitable for future trading than wheat. Nothing in the nature of the commodity itself stands in the way of a broad future market. However, such a fat and oil future market cannot be developed unless the industries using and producing fats and oils extensively practice hedging and trade in futures. This is not the place to discuss the ethics of future trading by amateurs; nor the abuses that have developed at various times and places. Our purpose is to point out that future trading has a very legitimate use for the merchant and the manufacturer. It allows him to avoid gambling in his raw materials and to confine himself to his proper sphere, manufacturing or merchandising. This is the legitimate function of hedging in the flour milling and the spinning industry.

While it was difficult before the introduction of hydrogenation to create a future market for more than one or two products such as cotton oil and lard, it should be possible at the present time to create a wider future market because of the greater interchangeability of fats and oils. When this is done, manufacturers will be able to protect themselves, as millers and spinners do today, by hedging, and the industry will never again have to face the conditions which have resulted so disastrously for it. The public must come to look upon trading in futures, legitimately done for purposes of hedging, not as gambling, but as insurance against the risk of violent fluctuation, indeed as a method of avoiding gambling. Some form of insurance is necessary for users of such raw materials as fats and oils. Perhaps some day someone will invent a method better than hedging. Up to the present time no such method applicable to our existing economic system has been devised. Until it has been, we shall have to countenance future trading despite some evils that attend it, because it is the only practical method of insurance hitherto developed.

The growth of a broad international future market for fats and oils in general will not be a simple matter nor one that can be accomplished over night. The existence of different tariffs in different countries greatly confuses the situation. The methods and technique of other future markets, grain, cotton, stocks, may not prove suitable in all respects for fats and oils. Whether a broad future market for tallow and lard could be developed at present is doubtful. Whether the market should recognize only crude or only refined oils or both is a further question. However, an efficient future market for vegetable oils seems possible. In such a

market cottonseed, peanut, corn, soy bean, palm and palm kernel oils all oils that through hydrogenation and refining are largely substitutable, would have to be deliverable with an appropriate range of premiums and discounts. Otherwise no breadth could be attained in the market.

It may be urged that these oils are not perfectly interchangeable. True, but neither are different kinds of wheat. Yet the wheat trade has met the situation in the following manner: When a wheat future is closed out, with the seller rests the choice of the grade or class in which he wishes to make delivery. This is adjusted to the contract grade by a system of premiums or discounts, as the case may be, usually discounts. The range of premiums and discounts is variable from year to year. For example, the Liverpool contract is fulfillable ordinarily by No. 2 hard winter and No. 3 Manitoba, but it is fulfillable with any wheat above or below, on the basis of a premium or discount adjustment, which is fixed by a committee from year to year and may vary rather widely.

Experience will have to show how the practices of other commodity markets need to be adapted to the peculiar conditions that prevail in the world trade in fats and oils. It is believed, however, that the difficulties are not insuperable, for fats and oils possess in a high degree the properties that are essential for future trading. The market for them is world wide; they are not very perishable; they can be graded and standardized easily and exactly. These are the characteristics that make deliveries on future contracts possible.

Let not the manufacturer expect that with the development of such a market all he has to do to insure himself against risk is to hedge. He will not himself be competent to practice hedging and also direct his manufacturing operations. He will have to employ or consult specialists for this purpose as has been found necessary in other industries, for example milling. Great mills employ their own corps of specialists; smaller ones consult with their grain brokers. No doubt the time will come, even in the fat and oil trade, when manufacturers will consult with and operate through specialists in the matter of the purchase of raw material just as they already depend upon lawyers for advice on matters of law and bankers for advice on matters of finance. Speculation and the talent for speculation are very different from manufacturing and the talent for manufacturing. Rarely will the same brain combine both kinds of talent.

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DETERMINATION OF THE IODINE ABSORPTION AND FOOTS FORMATION OF LINSEED OIL

By Glenn H. Pickard

The examination of commercial as well as edible oils is divided into two distinct considerations, purity and quality. Just as it is possible to have a perfectly pure edible oil that is unsatisfactory for use as a food because of off-flavor, for instance, so it is possible to have a pure oil, such as linseed or china wood, which is unsatisfactory for use because of certain properties which it possesses or lacks.

There has been considerable study of the quality of linseed oil, one of the most important industrial oils of our commerce. The American Society for Testing Materials, through Committee D-1 on protective coatings, and through a sub-committee of this committee on linseed oil, has conducted a study of both purity and quality over a period of several years. A resumé of the work of this committee is fraught with interest.

Iodine Number

The iodine number, which measures the percentage of iodine absorbed by an oil, is an important indicator of both purity and quality. It measures the number of double bonds or unsaturated linkages in the hydrocarbon chain of the oil molecule. Because the number of these linkages is characteristic of various oils, and because the drying power of an oil is dependent upon the number of these unsaturated linkages, the iodine number is a measure of both purity and quality. It is not, however, an absolute measure of either, for the number of unsaturated linkages varies with the same oil, dependent upon agricultural conditions obtaining during the development of the seed. Also, the total of double bonds measured by the iodine number does not necessarily fully measure quality. Two oils of the same iodine absorption may yield films varying in elasticity, hardness and toughness because of the distribution of these double bonds. The qualities mentioned measure, to some extent, the service-giving properties of protective coatings of which the oil is a constituent.

The greater the degree of unsaturation in any molecule the harder and tougher will be the product of oxidation of that molecule. There are in linseed oil in varying amounts the glycerides of linoleic, linolic, oleic, and saturated acids, together with some mixed glycerides. The extremes of unsaturation are in linoleic acid with three double bonds, and oleic with one. The former dries to a hard, tough film, while the latter, even when completely oxidized, is still a viscous liquid. Linolin dries to a rubber-like solid. The unoxidized portions of an oil are dispersed throughout the film after drying, and tend to make it soft and cheesy. That is, they reduce simultaneously the hardness and the elasticity of the film.

It is obvious that a film produced by the oxidation of a mixture of linolein and olein would not possess the service-giving qualities of one which contained more linolin, the middle glyceride, because in the latter case the oxidation products would all be solid, whereas in the former the film would be a mixture of hard and soft portions. In other words, it is better to have a minimum of the extremes with more of the middle portion than the reverse. It is also clear that the iodine number would not indicate the distribution of the unsaturated linkages, and therefore absolutely indicate the quality. However, while the iodine number does not give a positive proof of quality, yet it is obvious that the higher the iodine number, the better the oil when used in protective coatings where its ability to oxidize is essential.

The methods of measuring the capacity of an oil to absorb iodine or oxygen are of interest. The first one of prominence to be employed was the Hübl method. While still used by some it is not so widely employed as it once was. The objections to it are the time required for absorption, the incompleteness of the absorption, and the lack of permanence of the solution. It has been found to give inaccurate results, especially on high iodine number oils. It has not been used on linseed oil for a number of years, though it is still employed by a few for china wood oil. The other methods in general use are those of Wijs and Hanus. The Wijs method is based upon a solution of iodine chloride in glacial acetic acid, while the Hanus consists of iodine bromide in glacial acetic acid. Both of these methods are very widely used today.

Some years ago the Association of Official Agricultural Chemists studied the methods for the determination of the iodine number. They concluded that much better results are obtained by the Wijs and Hanus solutions than by the Hübl, and that the Hanus method gives results much more closely agreeing with the existing data than the Wijs. They made the Hanus method official at that time. When the American Society for Testing Materials began its work upon the iodine number they accepted the results of the Association of Official Agricultural Chemists, and accordingly adopted the Hanus method without investigation. As a consequence all of the existing data of this Society on the iodine absorption of linseed oil was obtained by the use of the Hanus method. A few years ago a committee on the analysis of commercial fats and oils of the American Chemical Society, after a careful study, recommended the use of the Wijs method for the determination of the iodine number. Their report said that this method was adopted after a careful comparison with the Hanus and Hübl methods. The Hübl method was eliminated from consideration almost at the beginning of the committee's work for the reason that the time required for complete absorption of the iodine is unnecessarily long, and in fact, even after absorption has gone on over night, it is ap-

parently not complete. In the case of the Hanus and Wijs methods, complete absorption takes place in from fifteen minutes to an hour, depending on conditions. Formerly, many chemists thought the Hanus solution rather easier to prepare than the Wijs solution, but the experience of the committee was that the Wijs solution was no more difficult to prepare than the Hanus. Furthermore, absorption of iodine from the Wijs solution appeared to take place with greater promptness and certainty than from the Hanus, and was complete in a shorter time. Results by the Wijs method were also in better agreement in the case of oils showing a high iodine absorption for the same length of time. However, the difference was not great.

Recently the American Society for Testing Materials' Committee made a comparison of the results obtained by the application of the Hanus and Wijs methods upon linseed oil. Some of the reasons for the investigation were that the Hanus solution cannot be used to determine the iodine absorption of china wood oil or shellac, both important commodities closely paralleling linseed oil in distribution. Therefore it was necessary to have two solutions in laboratories where these three materials were to be tested. Obviously it was desirable to use one solution if such a procedure was found practicable. This situation was one of the reasons which led the American Society for Testing Materials to begin an investigation comparing the Wijs and the Hanus methods. The details of the procedure for the Wijs method were those recommended by the committee of the American Chemical Society, which worked them out for high iodine oils and also especially for china wood oil. The results obtained by this committee show that there is little or nothing to choose between the two methods from the standpoint of accuracy. In general the concordance between the various operators was very good by either method.

In work done during 1921 the average difference in per cent of iodine absorbed as measured by the two methods was $4^1/_2$ per cent. The results of the Wijs method were the higher, as was expected. In 1924, the average difference was 4.6 per cent. It therefore appears feasible in the case of linseed oil to convert results obtained by the Hanus method to their equivalent in Wijs figures by the addition of $4^1/_2$ per cent. This makes it practicable to change specification figures as well as to compare existing data obtained by either of the methods. Because there is no difference in the accuracy of the two, and because the Wijs method is more generally applicable, and because there will be no difficulty encountered in the comparison of existing data with that to be acquired, it is the writer's opinion that the Wijs method is the better one to use because of its wider applicability in the analysis of the materials used alongside of linseed oil, especially in the case of china wood oil and shellac.

Summing up, the American Society for Testing Materials has found that

the iodine number is a very valuable indicator of purity and of quality, and that it should be an item of any specification; that it can be satisfactorily measured by the use of either the Wijs or Hanus methods; that the results obtained by the Wijs method will be approximately 4½ per cent higher than with the Hanus; that the only weakness of the determination is that limits of such a spread must be used, because of the variation in the iodine number of pure linseed oils, that there is made possible an apppreciable adulteration of a high iodine oil with a low one without falling below a practical minimum. The quality indications of the iodine number are also somewhat akin to those of purity in that it is possible to have oils of practically the same iodine absorption which will yield products varying in important qualities.

Determination of Foots

Another indication of the quality of linseed oil is the amount of suspended or precipitated matter which it contains. This sediment is termed foots. The formation of it is gradual, proceeding at rates varying with the nature and composition of the oil and with the conditions obtaining during the period of separation. The foots of raw linseed oil comprise three main elements which vary in amount. They are, first, the high melting point, saturated fats which are solids at normal temperature; second, the so-called mucilaginous materials dissolved by the oil from the remaining portions of the seed during the crushing process; and third, water.

Obviously the amount of high melting point fats will vary with the composition of the oil, which, in turn, depends upon natural conditions prevailing during the growth of the flax plant. Inasmuch as these bodies are liquid above a certain temperature and solid below it, the amount present will vary also with the temperature at which filtration takes place. If that is below the point of solidification, removal will be accomplished, but if above, they will remain in solution.

The solubility of the mucilaginous materials is affected to a lesser extent by temperature, though a portion of the amount originally present in the freshly crushed oil is undoubtedly removed by filtration at comparatively low temperatures. Time is an important factor in the removal of this material, since a gradual precipitation occurs.

Moisture is dissolved by the oil during the operations of crushing. Generally speaking, the more moisture there is in the ground seed as it goes to the hydraulic press the more water there will be dissolved in the oil. The amount will, of course, be dependent upon the ability of the oil to dissolve it. Within certain limits the higher the temperature of the oil, the more water there can be present without producing a cloudy liquid.

All three of these materials are present in the oil in the colloidal state, which state in this case is not a permanent one. The result is that, as

the oil ages, varying portions of all three separate out, thus improving the quality of the supernatant liquid.

To measure the amount of foots or potential foots in linseed oil has been a problem upon which much thought and effort has been expended by the American Society for Testing Materials.

The first test devised was one which allowed a measured volume of oil to deposit foots in a graduated vessel over a definite period of time. This method was found impracticable because of the time required, the varying density of the deposit, and the incompleteness of the precipitation. Later, precipitation from a solution of oil in petroleum ether was tried. This failed for the reasons just given, and also because of the variations in the solvent power of the different petroleum products used. Acetone as a solvent was next tested. It also gave unsatisfactory results when used alone. Walker and Wertz modified this method by employing with the acetone a ten per cent hydrochloric acid solution saturated with calcium chloride. This method has given greater satisfaction than any other, but the committee has found it so inaccurate as to prevent the inclusion of it as an item of a standard specification. Recently the effect of the variations in temperature upon the oil previous to the determination of the foots content was thought to account for discordant results. The oil was warmed before making the determination in order to eliminate such an effect, but the concordance of results, while improved, was not great enough to permit the test to be described as accurate.

The use of the centrifuge under standardized conditions was also tried, but it made no improvement in the results. In its last report, the committee said, "The results obtained are very similar to those obtained in previous years. There is the same lack of concordance that has always existed when this test has been applied to the same oil by different operators. There is also the same lack of concordance that has always existed when the same oil has been tested by the same operator after it has been subjected to varying conditions which it might meet in commercial practice, such as temperature variations. A variation in the method by heating the oil previous to mixing with the reagents improves the concordance slightly, but not sufficiently. The variables involved in the method seem to be too great to allow of satisfactory results. The sub-committee, therefore, must reluctantly reaffirm the position taken in its last year's report, namely, that neither this test nor any modification of it proposed to date is sufficiently accurate for use in standard specifications." The committee realizes the necessity for an accurate test for the determination of foots and potential foots, and is at present studying means of determining the amount of the "break," that is, the material which separates out when the oil has been heated to temperatures usually between 400 and 500 degrees Fahrenheit. Thus far the conditions under which this

separation must be made have not been so closely defined that satisfactorily concordant results were obtained.

A study of the percentage of the ash of the oil is under way. Apparently, because of the variation of the amount of the ash of the different foots-forming materials this determination will not give satisfactory indication of quality. Because of the high ash of the materials which form the break, their presence in excessive amount will be indicated. But moisture and high melting-point fats will not be included. The elimination of the moisture is, of course, unimportant, because that can be determined in another way.

The situation as it now stands is that there is no satisfactory determination, or set of determinations for the estimation of the quality of linseed oil. There is, however, sufficient data to warrant the continuation of investigations to the end that quality determination can be satisfactorily and accurately accomplished.

IS THE BLEACHING ACTION OF FULLER'S EARTH DUE TO OXIDATION?

By Clarence W. Benedict

Fuller's Earth is essentially a clay. It differs from ordinary clay in that it is derived from Hornblende and Augite rather than from Feldspars. It contains hydrous aluminum silicates and has a marked colloidal structure.

A large amount of research work has been done on Fuller's Earth to determine just why it bleaches. The accepted theory has always been that the bleaching is the result of adsorption of the coloring matter by the earth.

However, this theory while generally accepted is as yet only a theory. Just why Fuller's Earth bleaches is still unknown. Dr. Wesson has advanced the theory that this bleaching power of Fuller's Earth may be due to oxidizing action of the earth upon the oil. This theory seems plausible in as much as oils can be bleached by treating them with strong oxidizing agents. It was the purpose of this study to determine whether or not oxidation had anything to do with the bleaching.

Procedure. The first step in the investigation was to determine the oxidizing power of the earth. This was done by weighing out accurately five grams each of twelve different earths, into 250 cc. volumetric flasks, and covering them with 50 cc. of carbonated water to drive out the air present and permit of working in an atmosphere of carbon dioxide. Next 25 cc. of Mohrs salt solution were added and the flasks filled to the 250-cc. mark with boiled, distilled, oxygen-free water. They were then shaken by hand for five minutes, allowed to stand and settle, until 50 cc. of clear liquid could be drawn off and titrated with potassium permanganate. Checks were made on each titration. Two blanks were run at the same

time to determine the amount of the Mohrs salt which had been oxidized by the air.

The permanganate and Mohrs salt solution used in these experiments were made up in the usual manner, approximately N/20. Sulfuric acid was added to the Mohrs solution to keep it from oxidizing, and each day the solutions were restandardized.

When the excess of Mohrs solution was titrated back, it was found that a certain number of cc. of permanganate were required to neutralize it. Knowing the equivalent of this many cc. of permanganate in terms of grams of Mohrs salt, and knowing also the number of grams of Mohrs salt added, the difference represented the number of grams of Mohrs salt oxidized by the earth. From this value the number of grams of Mohrs salt oxidized by the air in the blanks was subtracted. This gave the number of grams of Mohrs salt oxidized by the earth.

In actual practice the oils are bleached at the temperature of boiling water. The next problem therefore, was to see if the oxidizing effect of the earth was increased at this temperature. The experiments were carried out exactly as those above, and the results showed a marked increase in oxidizing activity. This increase was practically the same for all the earths.

The next problem which came up was to determine whether or not the earth was really oxidizing the Mohrs salt or just adsorbing it. In order to arrive at a decision, an adsorption isotherm was run on one of the samples of the earth. After two rather unsuccessful efforts, a third gave fair results. The curve, which for an adsorption should be a straight line was only approximately so. However, the points which were off the line were correct, as they were later checked. The curve does not show clear adsorption but only a tendency toward it.

If the bleaching was due to oxidation, it seemed possible that by reducing the earths with hydrogen in a hot tube, and then measuring its oxidation and bleaching powers, different results might be obtained than without this treatment. Of course this method is open to the objection that at this temperature some internal structure change might take place. However, the results obtained were fairly satisfactory. They showed that all oxidizing effect had been removed. In fact, the earths after this treatment reduced rather than oxidized the Mohrs solution.

To "reduce" an earth it was placed in a small alundum boat in a silica tube in the gas furnace and a stream of purified hydrogen was passed over it. The flame was then lighted and the boat left in the furnace for two hours; then allowed to cool with the stream of hydrogen still running.

The earths which had been treated with hydrogen did not bleach as well as they did before they were reduced. This may of course be due to some catalytic change or effect, but it is more probably due to loss of oxidizing power.

The bleaching tests were conducted on the earths in the following way. Fifty cc. of cotton seed oil were placed in a flask immersed in boiling water. Then 2.5 grams of earth added and the mixture stirred for three minutes, then filtered through filter paper in a steam jacketed funnel.

Conclusions. The oxidizing properties of the earths are roughly proportional to their bleaching powers. That is, Filtrol and Pikes Peak are the best bleaches, and they show the highest oxidizing power, while Floated Silica, which is the poorest bleach, shows a very low oxidizing power. The intermediate earths check up fairly well as shown in the following table.

OXIDIZING POWER OF BLEACH EARTHS—GRAMS OF $FeSO_4$ OXIDIZED BY 5 G. OF SAMPLE

Earth	Cold	Hot
XXF	0.0405	0.0542
—975	.0085	.0416
XL-000	.0199	.0445
Pikes Peak	.0875	.1372
Filtrol	.0434	.0750
Floated Silica	.0072	.0100
X-897	.0546	.0722
X-898	.0884	.1250
Georgia Fuller's Earth	.0107	.0552
Filter Clay	.0294	.0567
Tonsil	.0352	.0612
Unknown Quantity	.0436	.0655

The experimental work and results obtained during the research suggest the following conclusions.

1. Fuller's earth does oxidize different earths to a different extent.
2. The bleaching of oils by Fuller's earth is not due to oxidation alone.
3. The oxidizing power of the earth *is* a measure of its bleaching power.
4. The bleaching property of Fuller's earth is due to a combination of adsorption and oxidation. Dr. Wesson has suggested that the coloring matter is first oxidized and then adsorbed. This is, I think, a better explanation of its action than the straight adsorption theory.

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THE DISINFECTING POWER OF SOAPS

FROM "HANDBUCH DER SEIFENFABRIKATION"
BY DR. WALTER SCHRAUTH—5TH EDITION, 1921, PAGES 59–63
TRANSLATION BY L. W. BOSART

The opinions of the early authors differ widely concerning the disinfecting value of soaps. That soap can act as a disinfectant is nevertheless quite positively known at present, and recent research has established the conditions under which this disinfecting power is exerted and its extent.

The disinfecting power of soap was first established by Robert Koch,[1] who found in his investigations that ordinary soft soap in a dilution of 1:5000 could check and in a solution of 1:1000 could entirely inhibit the development of anthrax spores. Then in the year 1890, Behring[2] investigated some 40 different kinds of soap and showed that a "solid laundry soap" in a dilution of 1:70 in bouillon could kill anthrax bacilli within two hours. In 1894, M. Jolles[3] was likewise able to verify the disinfecting power of soap. In his tests, 3% solutions of 5 different soaps, whose content of fatty acid, alkali and free alkali was determined, killed cholera germs in 10 minutes; with increasing concentration and temperature, the disinfecting power likewise increased. Also in his later investigations[4] in which he made use of typhus and colon bacilli, he came likewise to the result that soap solutions possessed a considerable disinfecting power in themselves and that soap, therefore, was the most suitable and natural cleansing medium for soiled and infected laundry.

A. Serafini[5] also ascribes to ordinary laundry soaps and, indeed, to the pure fatty acid salts as such, a considerable disinfecting power and emphasizes the fact that all additions which reduce the amount of such salts in commercial soaps, likewise reduce the disinfecting action. But on the other hand, Konradi[6] in his investigations of the bactericidal action of soaps, using anthrax spores, arrived at the result that no appreciable disinfecting action can be ascribed to the soap substance, indeed rather, that any disinfecting action, if present at all, is due to certain additions, above all to such odor-bearing materials as terpineol, vanillin, cumarin, heliotropin, etc. His results were confirmed by tests from several other sources, but in general, later authors inclined again to the view that an antiseptic action can be ascribed to soap. Thus reported A. Rodet,[7] in 1905, concerning the disinfecting power of a pure soda soap (Marseilles Soap) free from excess alkali, whose effect he tried on staphylococci and typhus bacilli. In both cases, he was able to establish beyond question an antiseptic action. On adding soap to a culture medium, he checked the growth of bacteria even in weak concentrations, without, however, entirely suppressing it with very much larger additions. But with pure soap solutions, both kinds of bacteria were killed, indeed the more sensitive elements of staphylococci in a few hours with a 1% soap content, the typhus bacteria in a few minutes. With increasing concentration

[1] Robert Koch, *Mitt. Kaiserl. Gesundheitsamt*, **1**, 271 (1881).
[2] Behring, *Z. Hyg. Infektionskrankh.*, **9**, 414 (1890).
[3] M. Jolles, *Ibid.*, **15**, 460 (1893).
[4] *Ibid.*, **19**, 130 (1898).
[5] A. Serafini, *Arch. Hyg.*, **33**, 369 (1898).
[6] Konradi, *Ibid.*, **44**, 101 (1902); *Zentralbl. Bakt.*, **36**, 151 (1904).
[7] A. Rodet, *Rev. Hyg.* **8**, 301 (1905).

and rising temperature, in conformity with the observations of earlier authors, a swifter and more energetic action was likewise noticeable.

Finally C. Rasp[8] from his own experimental studies emphasized particularly the varying disinfecting action of commercial soft soaps and brought out the fact that neither the chemical analysis with regard to the alkali content, nor the chemical-physical investigation (conductivity) nor the identification of the fatty acids by means of the Hübl iodine value could fully account for these variations. Owing to the increased effect as a result of increased temperature, he believed, however, he might suggest dissociation and closed his work with these words: "Tests with soap made from chemically pure substances, might well add a further contribution to the theory of the action of soap."

Soon after that appeared the work of Reichenbach, in which this thought was made an actuality, the extensive experimental material of which now offers an almost complete explanation of the foregoing question. Reichenbach employed for his experiments the chemically pure alkali salts of all the acids which are usually found in soaps, neglecting almost entirely all commercial preparations, and was able in this manner to determine that the potassium soaps of the saturated fatty acids quite generally possess a very considerable disinfecting power, while the salts of the unsaturated fatty acids are scarcely worth considering as far as the disinfecting action of soaps is concerned. Above all other salts, potassium palmitate possesses an especially noteworthy disinfecting power. A N/40 solution (0.72%) was able to destroy B. coli in less than 5 minutes, something which would not be accomplished with an aqueous solution of 1% carbolic acid in 20 minutes. On the other hand, a N/10 solution of potassium oleate showed no appreciable action at all, and it required one hour for a N/2.5 solution to bring about even a partial destruction of the bacteria tested.

These experiments alone will explain a great part of the contradictions in the literature, for they show that it is very probable that *a soap possesses greater disinfecting power the more strongly it is hydrolyzed in aqueous solution*. Moreover this theory gains in importance, because it can be supported by an entire series of further observations. Reichenbach found further, that the disinfecting action of the alkali salts of the fatty acids diminishes with the decreasing molecular weight of the fatty acids as does also the hydrolysis. The only exception in this series is the stearate, which in spite of its higher molecular weight shows a somewhat weaker disinfecting power, but, at the same time, it shows a somewhat lower hydrolysis than the palmitate. Furthermore, corresponding to the conclusions drawn from the above statement, it could be shown among other things, that the disinfecting power of a soap solution diminishes at a lower

[8] Rasp, *Z. Hyg. Infektionskrankh.*, **58**, 45 (1908).

rate with increasing dilution than the corresponding dilution would anticipate. Since, namely, with increasing dilution, the hydrolysis of a soap solution increases, and, indeed, in such a manner, that the absolute amount of the hydrolyzed components is diminished but the percentage of the decomposed salt continually increases, therefore a portion of the result of the dilution must be counterbalanced by the relative increase of the products of hydrolysis.

In spite of the fact that the above explanation corresponds completely with the experimental data actually found, on close consideration the conclusion must nevertheless be reached, that the more or less hydrolyzed fatty acid salts alone cannot be the determining factor for the disinfecting value of commercial soaps. The results already obtained by Robert Koch, who, from his investigations made on fish oils and vegetable oils, ascribed to soft soaps made from these very oils, which are composed principally of unsaturated fatty acids, a high disinfecting power, cause one to presume that in this process of disinfection there are other contributing factors, which make it possible that a greater effect can sometimes also be ascribed to the soaps obtained from the unsaturated fatty acids.

It is only natural to think first of the excess alkali content of the soaps, especially since it appears obvious, in agreement with the views of the earlier authors (Behring, etc.) to ascribe the disinfecting power of the soap principally to the alkali soap freed by hydrolysis. In fact, Reichenbach also obtained strongly disinfecting liquids by combining a potassium oleate solution (with scarcely any disinfecting action) with a potassium hydrate solution, which likewise had only a weak action, and indeed the maximum of disinfecting value was attained with a mixture of $^1/_6$ oleate (N/50) with $^5/_6$ caustic potash (N/50). But contrary to the above hypothesis, as he himself was able to show and as other authors before him have already declared,[9] it would be quite wrong to consider the action of soap purely as an effect of the alkali, since soap solutions in most cases possess a stronger action than can be exerted under the most favorable circumstances by alkali alone. The significance of the excess potash would appear to lie less in its own disinfecting power than in its supplementing the disinfecting action of the fatty acid salts, and so Reichenbach summarizes the result of his investigations thus: "Alkali and fatty acid salts acting together bring about a mutual increase in their disinfecting power, and, indeed, a greater increase than would be produced by the same amounts in a solution of like strength of the same material."

The question of what causes this increase is left open, but its explanation should not be too difficult, if the process of disinfecting itself is considered.

For the effectiveness of a disinfectant, a certain fat solubility (lipoid

[9] See c. G. Serafini, *Loc. cit.*

solubility) of the same is necessary, and, indeed, it must be such that the disinfectant, because of its solution affinities, is given up with the greatest ease from an aqueous solution to the lipoid medium (the bacteria cells). It will therefore be understood that on the one hand, the acid salt, which is lipoid-soluble to a considerable extent, and which is produced together with the alkali by the hydrolysis of the saturated fatty acid salts, which acid salt is soluble with comparative difficulty in the aqueous medium, can easily go over to the bacteria cells, and that on the other hand also, the neutral salts of the unsaturated fatty acids which are easily soluble in water, will develop an activity if by being salted out of their aqueous solutions by electrolytes they now receive an increased solution affinity for lipoids. Again briefly summarized, *the disinfecting power of aqueous soap solutions is* therefore *dependent upon the relationship existing at the time between the alkali salts of the saturated and unsaturated fatty acids and upon the purity of the soap itself*, in that the action of the saturated soaps runs parallel to the relative amount of hydrolyzed fatty acid (or acid salt), but the action of the unsaturated soaps is essentially determined only by the salting-out power of electrolytes present at the same time. The combined alkali or alkali in excess which is present in soap solutions is, moreover, aside from its not very great disinfecting power, still of significance in that, on the one hand, owing to the kind of alkali, differences occur in the lipoid solubility of the acid salts of the saturated acids, on the other hand, owing to the kind and amount of alkali, changes occur in the physical properties of the soap solution itself (suppression of hydrolysis, influence on the micro-structure of the colloidal soap particles).

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ABSTRACT FROM ANOTHER JOURNAL

Government Publications.—One of the most valuable Government publications to the oil industry which has appeared recently is *Trade Information Bulletin* No. **322** of The Department of Commerce. This is entitled The Vegetable Oil Industry of France and has been prepared by Chester L. Jones, American Commercial Attaché at Paris and Wesley Frost our Consul at Marseille. It is not therefore a mere compilation of data culled from trade papers and miscellaneous sources, but a first-hand report of present-day conditions in the oil trade of France. The pamphlet of 21 pages, contains a general discussion of the Oil Supplies, Foreign Trade and Raw Materials of the French Oil Industry, an enumeration of the manufacturing centers and brief descriptions of the condition in which the oil-bearing seeds and nuts reach the French oil mills followed by tabulations of the imports and exports showing source and destination. One might wish that those portions of the report which cover the methods of pressing and refining the various oils had been made a little more complete but this has been so well handled in the earlier bulletins by Thompson that perhaps it is unnecessary, unless French practice has materially changed during the past ten years. H. S. B.